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Analysis and Design of G+3 Storey and G+25 Storey RC Frame Building Structures as per Indian Standard Codes

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Abstract - *A complete building is a complex structure in that case, the analysis and design of the structure by using manual calculations is being a lengthy and difficult procedure to carry out so, for a reason nowadays computer software is used to perform analysis, design as well as detailing, to avoid the time required in whole procedure and to avoid calculation mistakes. The present work deals with the analysis and design of multi-storey, G+3 Storey and G+25 Storey RC frame structures. Gravity loads and Lateral loads are applied as per IS 875 and IS 1893 (Part 1), analysis is performed by using codal provisions in IS 1893 (Part 1): 2016 and IS 456: 2000 whereas the design of this RC frames is confirmation with IS 456: 2000 by Limit State Method. Computer software ETABS is used for the analysis and design purpose. The principle objective of this work is to generate error-free models and analysed and design the structures without instability by using static and dynamic analysis procedure provided in the IS codes for particular site conditions and requirements.*

Key Words: *Analysis and Design, RC Frame, Multi-Storey Building, Static Analysis, Dynamic Analysis*

1. INTRODUCTION

In Civil-Structural Engineering the building is used to mean a structure having different components like roofs, floors, columns, beams, walls, doors, windows, ventilators, stairs, lifts, various types of surface finishes, etc. Nowadays there are various software packages are available in market for analysing and designing of structures viz. ETABS, SAP2000, STAAD.Pro, Midas, and RAM, etc. Population is increasing day by day the high-rise and low-rise RC frame buildings are popular in cities and rural areas respectively. As per IS 1893 (Part 1): 2016 Linear Dynamic Analysis shall be performed for all buildings, other than regular buildings lower than 15 meters in seismic zone II, but as per previous revision IS 1893 (Part 1): 2002 suggest the Dynamic analysis for buildings having height greater than 40 meters in seismic zone IV and V and 90 meters in seismic zone II and III and vice versa for Static analysis for regular buildings. Structural engineers and designers are facing various challenges for the most efficient and economical design. All the structural members within the building must satisfy strength and serviceability requirements up to its design lifetime with intended functions.

Design RC Frame structure is a complex procedure because of various provisions and requirements should follow as per codal provisions. Present work will give the total concept and technical aspects included in the design of RC frame structure in computer software with respect to IS codes.

1.1 Design Philosophy: Limit State Method

For the Design of Reinforced Concrete Structures there are three philosophies namely:

1) Working stress method

2) Ultimate load method

3) Limit state method

Here in this project work, we are following IS 456:2000 so that we are using the Limit State Method of Design by Limit State of Collapse and Limit State of Serviceability.

1.2 Stages of Work

The whole work involves the following stages

- Structural Planning
- Estimating Loads
- Analyse the Structure
- Design the Structure

2. OBJECTIVES

1. To perform analysis and design of structure without any type of failure.
2. To understand the preparation procedure of the 3D model of the structure in ETABS.
3. To understand the terms and parameters in the design of different structural components
4. To understand the basic principles used in the design of building structures with respect to IS codes for particular site conditions.

3. SCOPE OF THE STUDY

To provide the appropriate analysis and design procedure, for building frame structure in computer software ETABS which requires less time as compare to manual method of calculation. These steps are also somewhat similar to other

software which are used in the structural design industry for analysis and design purpose.

4. METHODOLOGY

To achieve the objectives of the present study i.e. to analyse and design building structure by using ETABS following methodology is adopted.

Step 1: Prepare a Centerline plan

Once the architectural plan is ready the work for structural analysis and design begins with structural planning, from making a beam-column layout and then framing it in a centreline plan.

Step 2: Model Initialization in ETABS

For design purpose and ease in use with the units within software model initialization is to be set at the start of the project in ETABS.

Step 3: Layout Grid for required Spacing and Story Data

As per our centreline plan for the beam-column layout, a grid is plotted in software for the preparation of model also the story data for story height is also provided within the software.

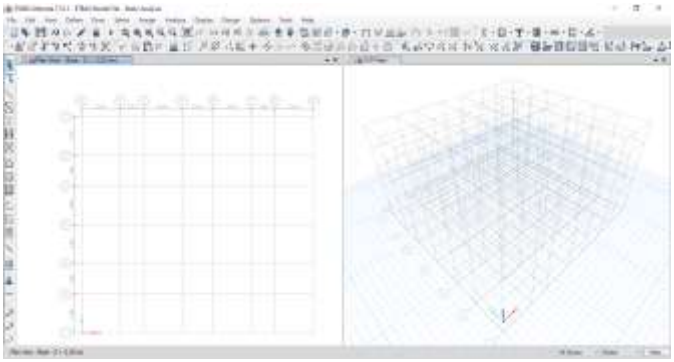

Fig -1: Grid and Story of G+3 Storey Building Model

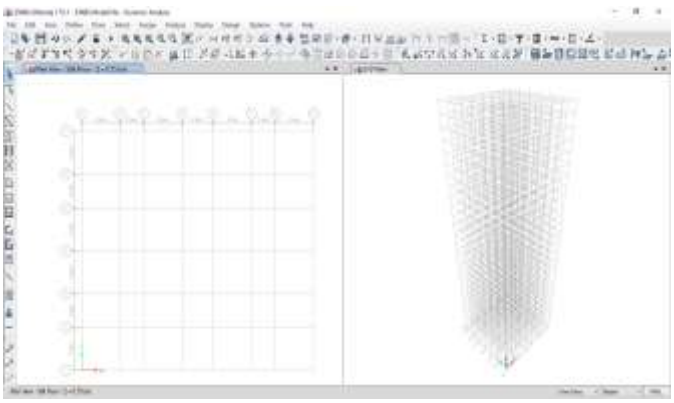

Fig -2: Grid and Story of G+25 Storey Building Model

Step 4: Enter Materials and Section Properties

Various materials which we decided to use within elements of the structure are to be defined as per their physical and other engineering properties, also the different section sizes for beams, columns and slabs which will present in the structure are needed to define in section properties.

Step 5: Model The structure

Now we have our different structural elements so, as per architectural drawing and structural planning we draw the model of the structure and also provide the support conditions to the structure.

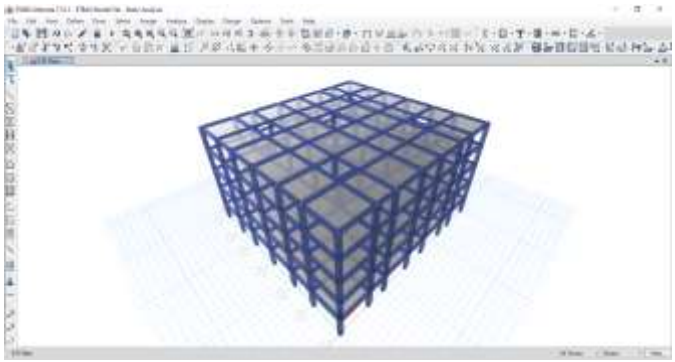

Fig -3: Toggle View - G+3 Storey Building

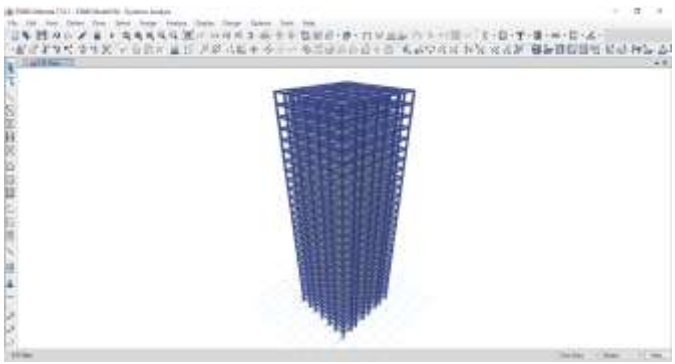

Fig -4: Toggle View - G+25 Storey Building

Step 6: Apply Loads

As per the type and requirement of the structure, Loading is to be applied, dead loads for floor finishes and live loads as per the type of room are applied for a particular type of structure as per IS 875 (Part 1): 1987 and IS 875 (Part 2): 1987 respectively. Lateral loads like wind and earthquake should also be taken into consideration and should be applied as per IS 875 (Part 3): 2015 and IS 1893 (Part 1): 2016 respectively.

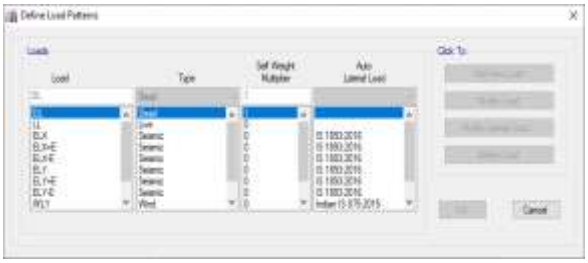

Fig -5: Load Pattern

Step 7: Form Load Combinations

By using IS 1893 (Part 1): 2016, IS 456: 2000 and IS 875 (Part 5): 1987 load combinations are to be defined for analysis and design of a structure.

Step 8: Analyse the Structure; Check for Codal Provisions and Requirements

Before starting to analysis, in a multi-storey building as per IS 875(Part 2): 1987, live load reduction factor should be applied for columns. The model should be mesh and perform check on the model for any modelling error. Analyse the structure in such a way the basic checks for instability and error should be checked and also the various checks provided in IS Codes are to be performed and satisfy for codal requirements. Checks are applied concerning the type of analysis is perform like Stability Check as per IS 456:2000, also Check for Base Shear, Modal Mass Participation and Minimum Frequency, Torsional Irregularity Check, Story Drift, Centre of Mass and Rigidity as per IS 1893 (Part 1): 2016

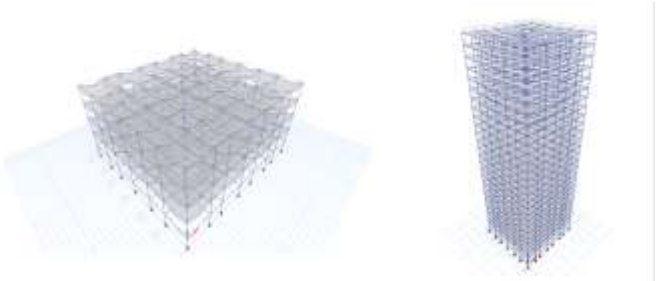

Fig -6: Deflected Shapes due to DL on the Structure

Step 9: Design the Structure; Apply Design Checks

After the analysis checks are satisfied the codal provisions and requirements, diameter of bars preferred in design and minimum spacing in the ties and stirrups are provided as per IS 456:2000 design of the structure is to be done and as per reinforcement requirement, check for design is performed and finally Model is check for All members are passed the design check in software itself.

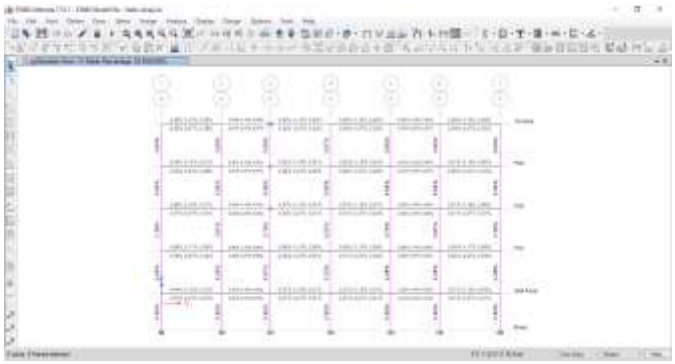

Fig -7: Design of Elevation View - G+3 Storey Building

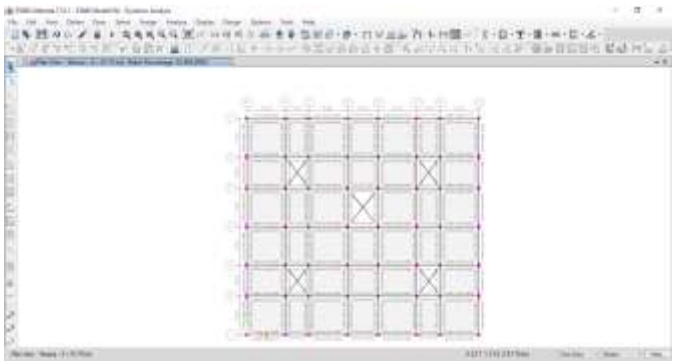

Fig -8: Design of Plan View - G+25 Storey Building

Fig -9: Verification of All Members Pass Design Check

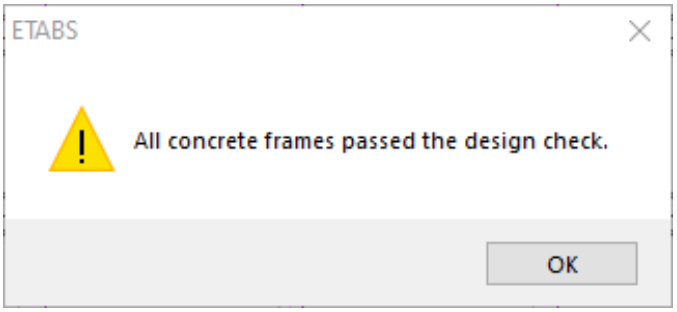

Fig -10: Verification of Analysis vs Design Sections

5. RESULTS AND DISCUSSION

Analysis and Design of G+3 Storey and G+25 Storey RC frame structures by using static and dynamic analysis respectively are done by using software ETABS version 17.0.1 without any error and structural instability, all the checks are performed and satisfy the requirements which are stated in IS 1893 (Part 1): 2016 and IS 456: 2000.

All the required checks are performed to check the stability and safety of the structure. All the parameters in IS 1893 (Part 1): 2016 for earthquake resistant design are also checked. By following the correct method of approach by using software ETABS it seems somewhat easy to analyse and design a multi-storey building in software as compare to the manual-conventional method of analysis and design.

6. CONCLUSION

ETABS is an extremely powerful tool that we adopted to serve the intended purpose of this project work. The work has been executed and designed as per codal provisions provided in IS codes. By the usage of ETABS software for analysis and design, it minimizes required time in whole procedure. As per the analysis for the particular members for the different parameters shear forces, bending moments, axial forces, torsional moments, etc. along the members indicates that member resists the loads, and in that way, we get to know the behaviour of the structure in various aspects.

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